VELO Sensor and Module Alignment

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Tracking & Alignment Workshop – 3 June 2010

Outline

- Alignment for Module and Sensor alignment with 2010 collision data (similar to what were presented last week, but fixing some twist/scaling effect).
- Comparison 2010 align with Metrology, with Ted align and v3.1
- Conclusion

All the results and plots are preliminary!

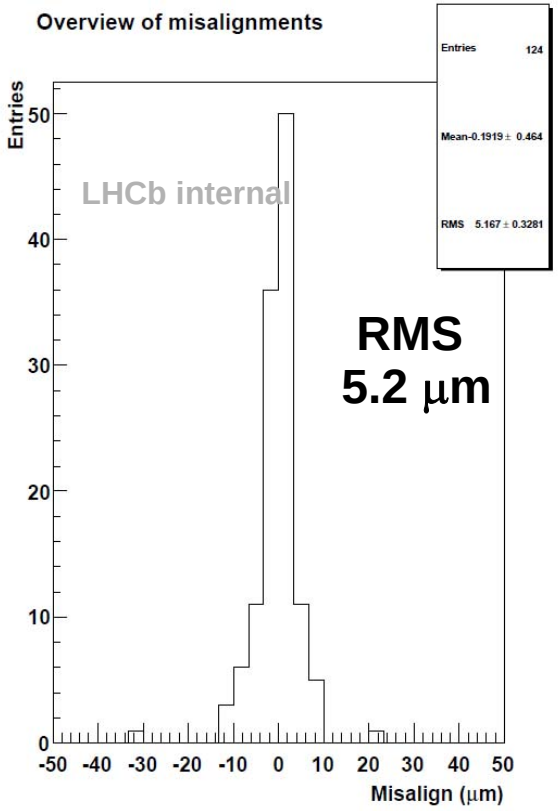
Sensor misalignment monitoring

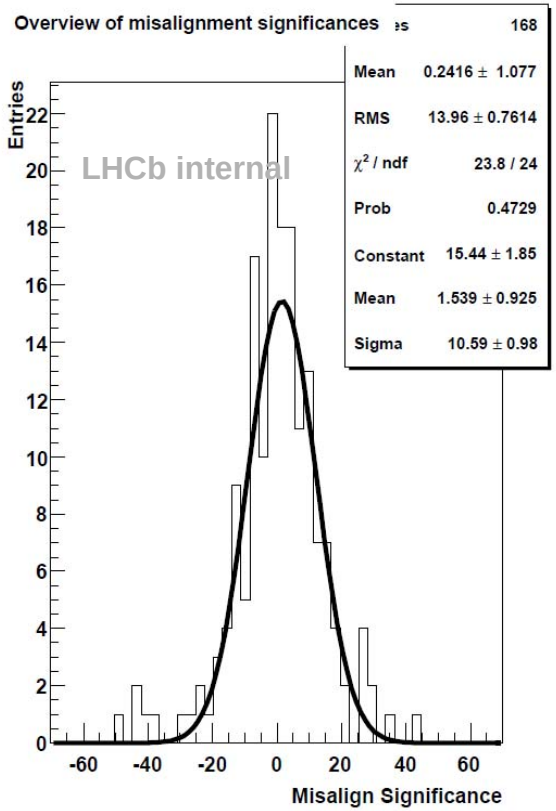
- R and ϕ residuals has a sinusoidal dependency on the misalignment

$$residual_R = -\Delta x \cos\phi_{track} + \Delta y \sin\phi_{track} \quad (R \text{ sensor})$$

$$residual_\Phi = \Delta x \sin\phi_{track} + \Delta y \cos\phi_{track} + \Delta\gamma r_{track} \quad (\Phi \text{ sensor})$$

This method neglect the effect of Rx and Ry





Procedure of Sensor and Module alignment

- Preliminary results shown last week were affected by a a twist and a scaling.
  - The scaling disappears when we don't align for Tz for the sensor
  - The twist was introduced in Millepede (not really constraint Rz)
- Fix again Rz as Metrology and align by Kalman:
  - Kalman for the module Tx Ty Tz Rx Ry Rz and for the sensor Tx Ty [fix two modules in each side]
- Select events with halo tracks by PatVeloAlignTrackFilter
- Run 69355 about 1 milion events
  about 200 k tracks

Metrology Accuracy

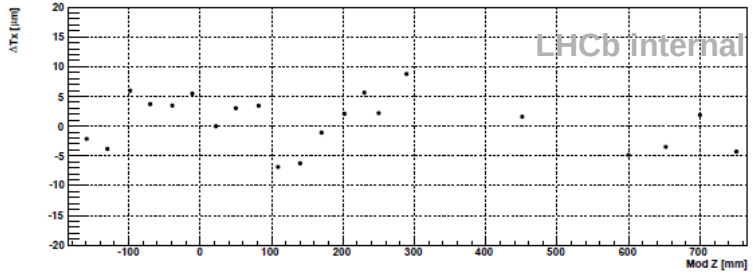
- Sensor
  - Tx Ty 3 μm
  - Rz 20 μrad
- Module
  - Tx 15 μm
  - Ty 50 μm
  - Tz 200 μm
  - Rx Ry 1 mrad
  - Rz 0.2 mrad

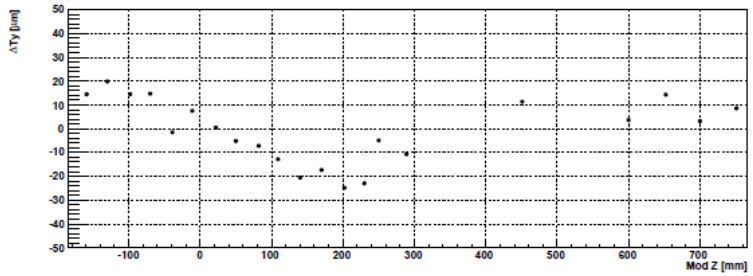
This does not include any temperature effect

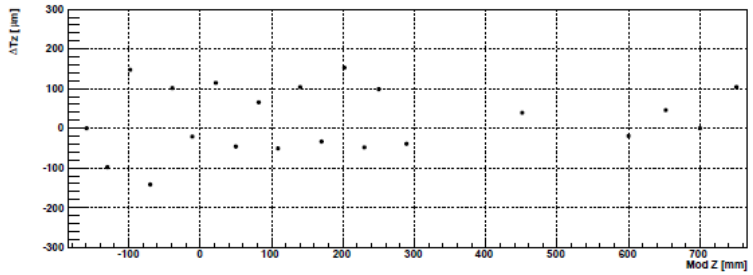
Alignment constants: Metrology - 2010

Right side Translation

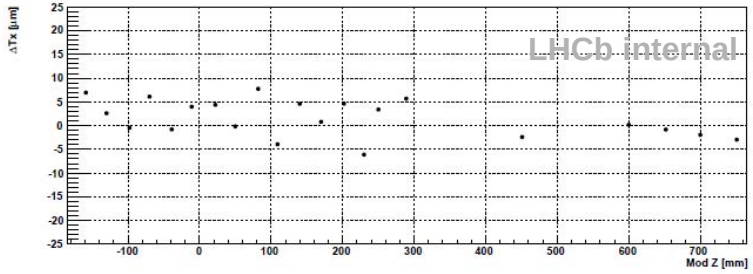
Module

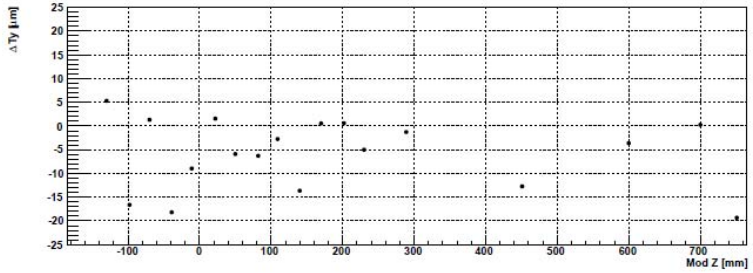


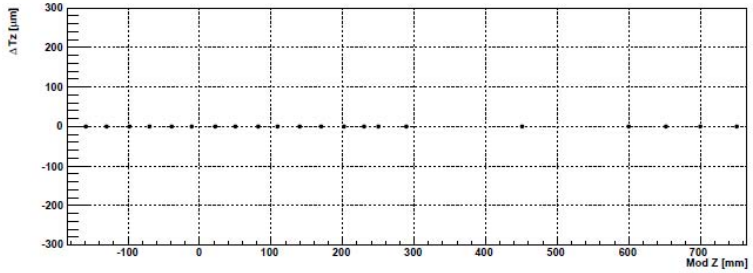




Phi sensor



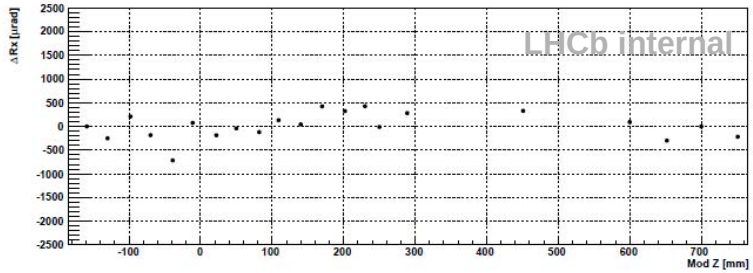


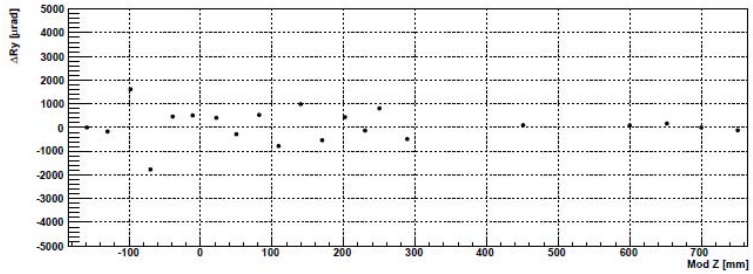


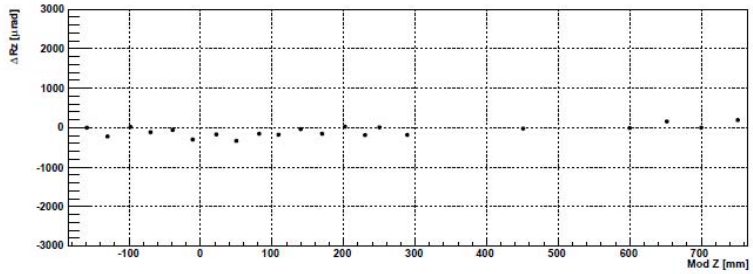
Alignment constants: Metrology - 2010

Right side Rotation

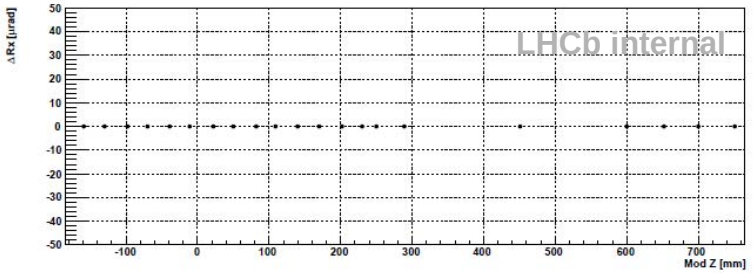
Module

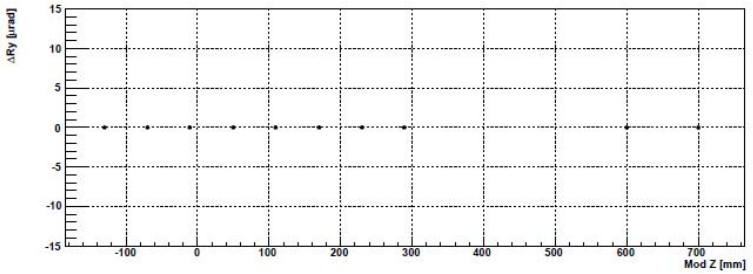


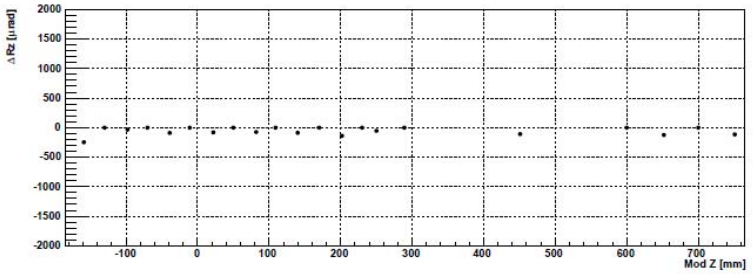




Phi sensor



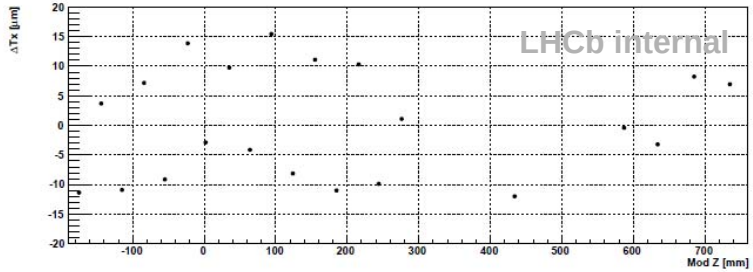


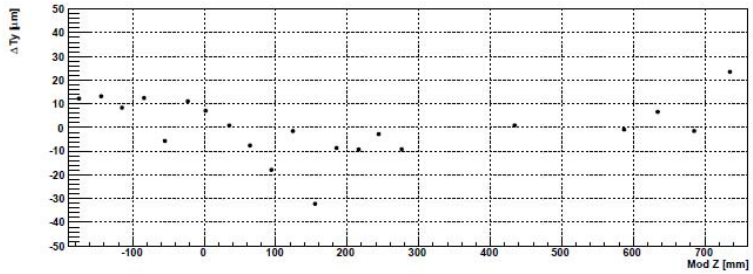


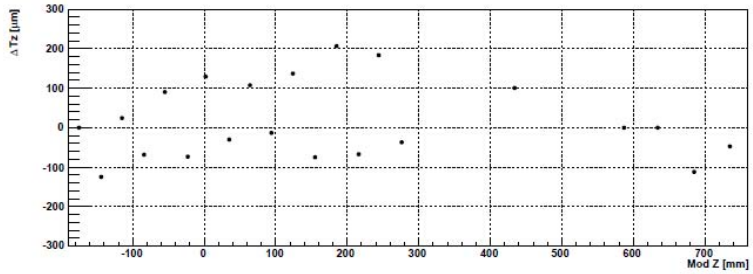
Alignment constants: Metrology - 2010

Left side Translation

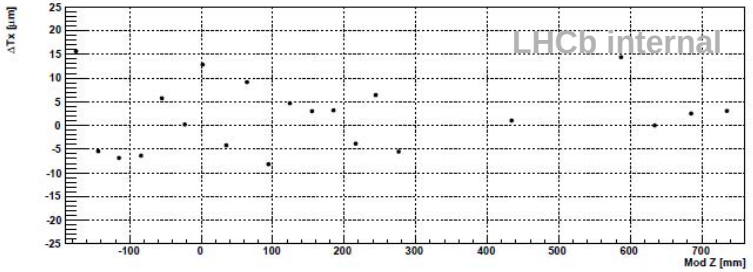
Module

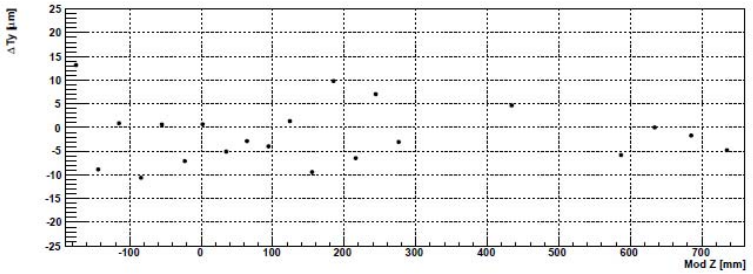


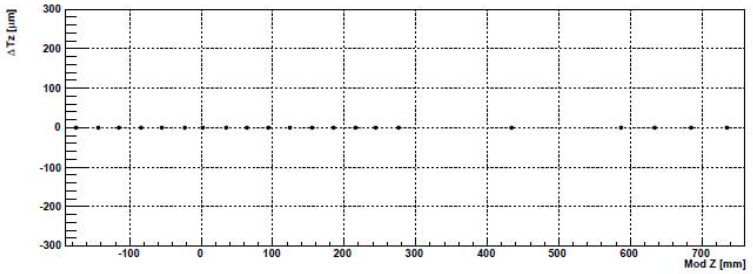




Phi sensor



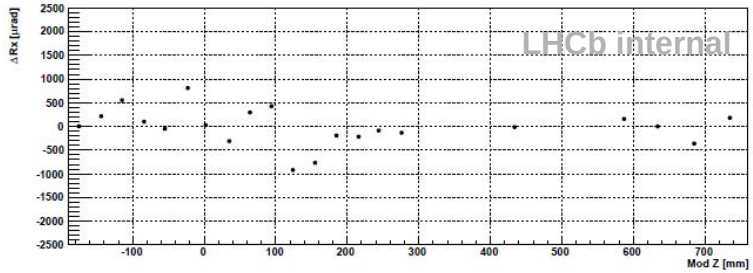


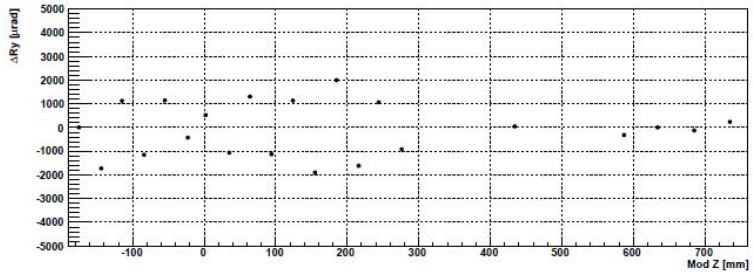


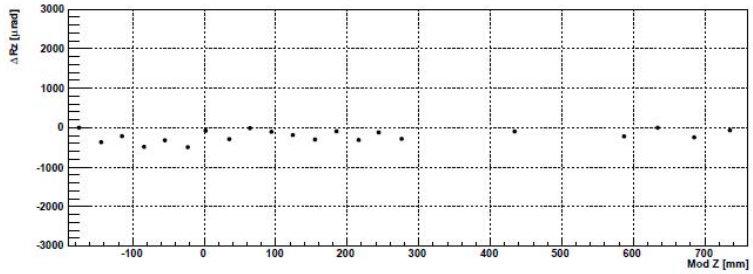
Alignment constants: Metrology - 2010

Left side Rotation

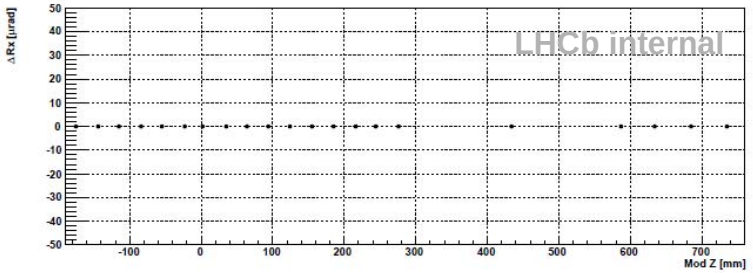
Module

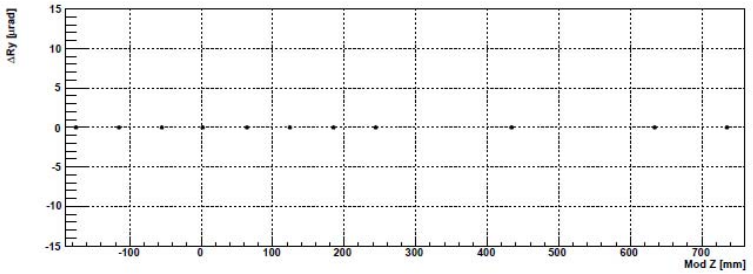


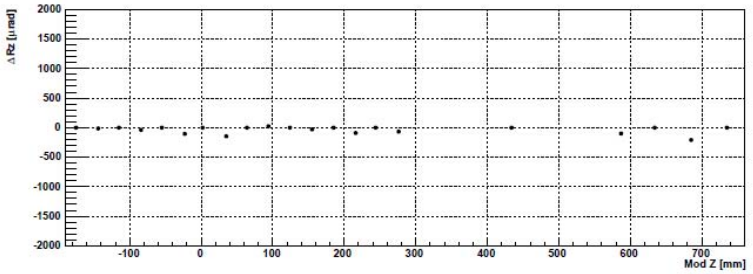




Phi sensor



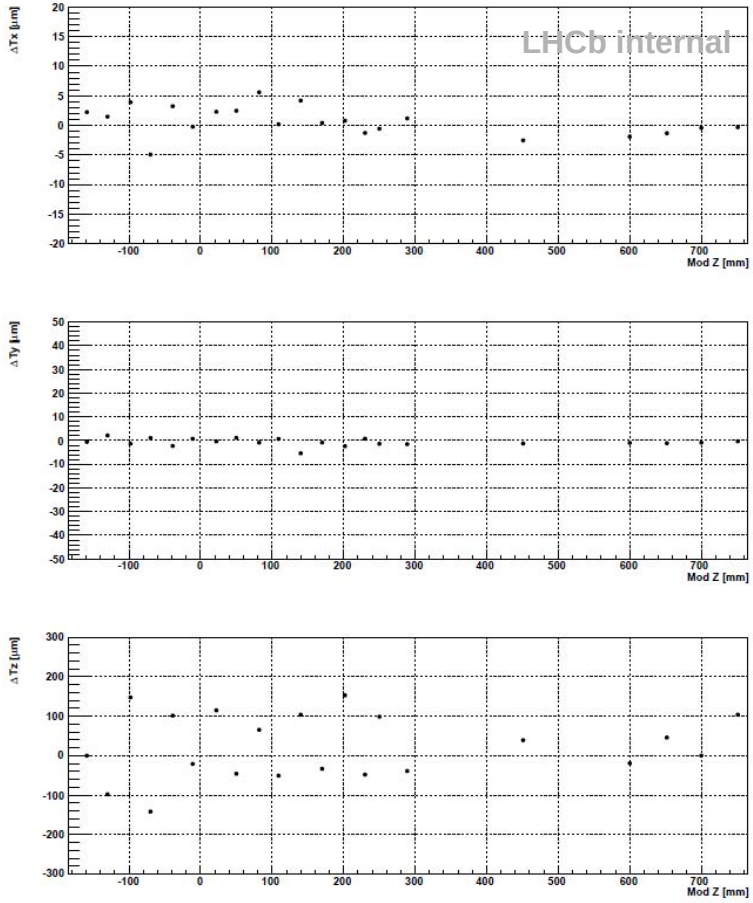




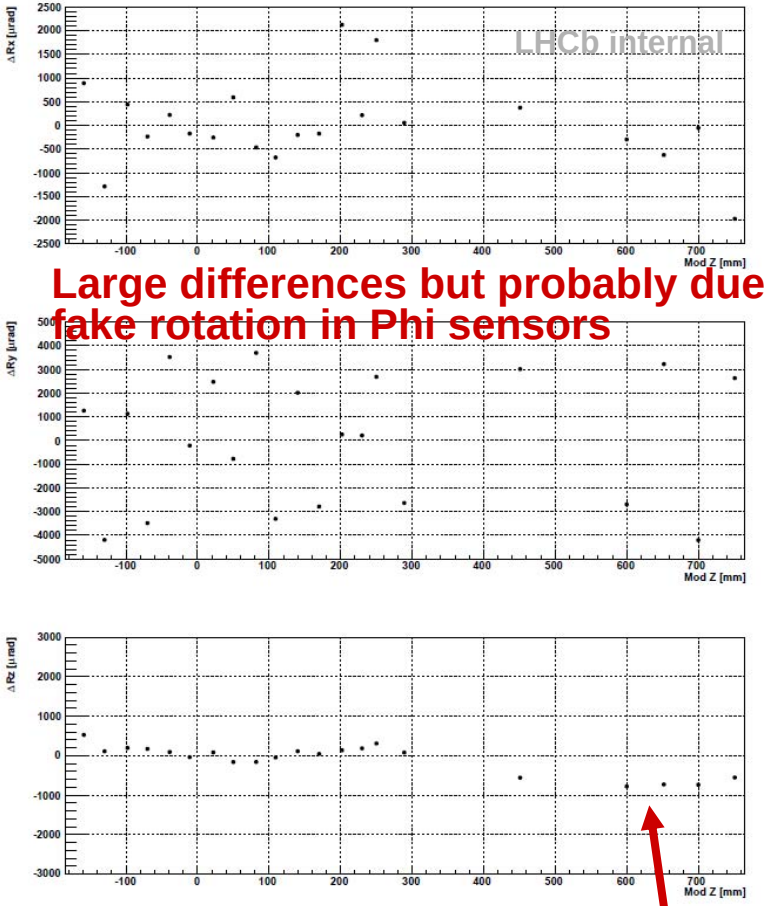
Alignment constants: CurrentAlign - 2010

Right side

Module Translation



Module Rotation



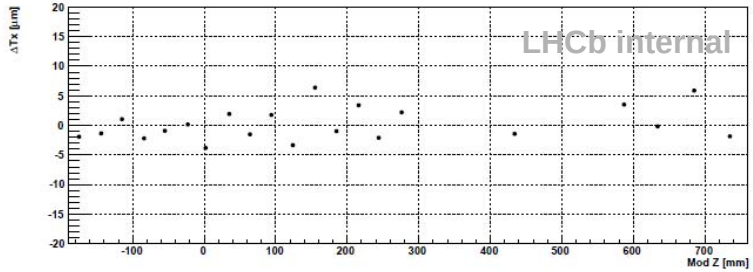
Large differences but probably due to fake rotation in Phi sensors

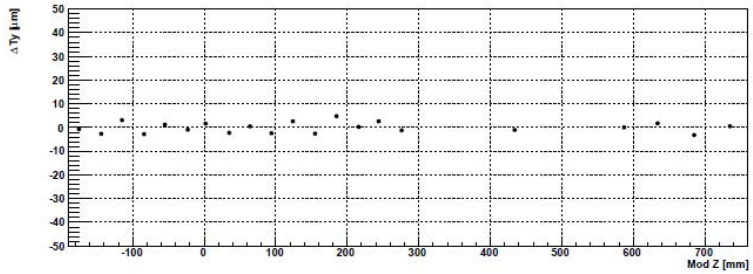
Some twist effect in forward region

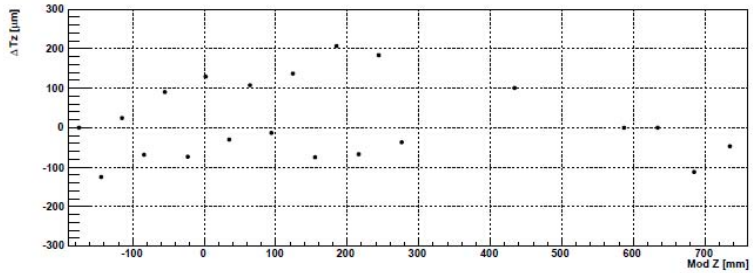
Alignment constants: CurrentAlign - 2010

Left side

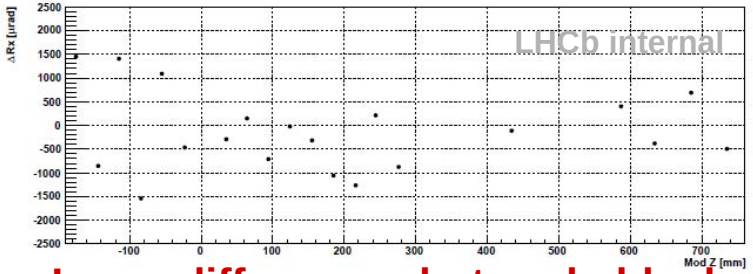
Module Translation



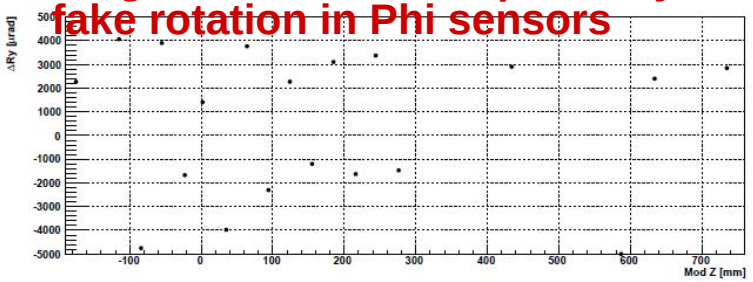


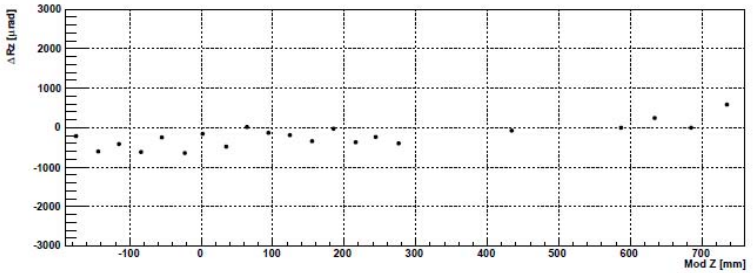


Module Rotation



Large differences but probably due to fake rotation in Phi sensors

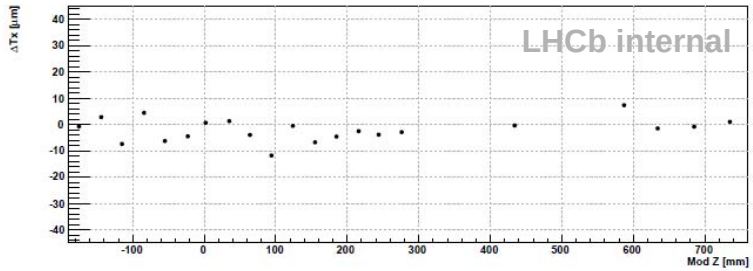


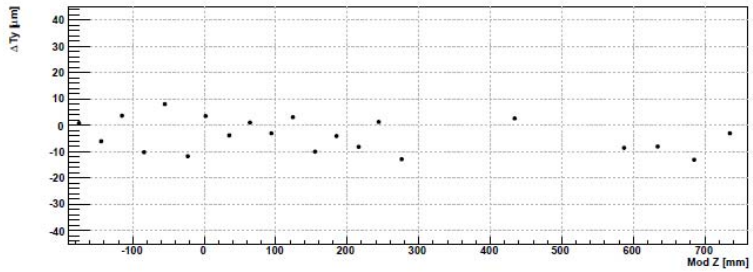


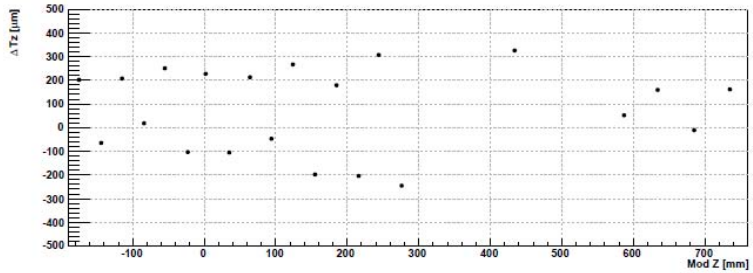
Alignment constants: CurrentAlign - 2010

Left side

Sensor Translation

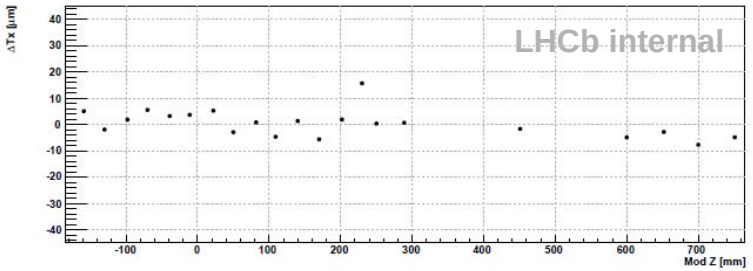


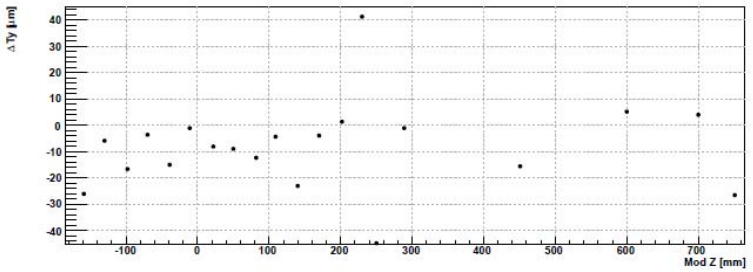


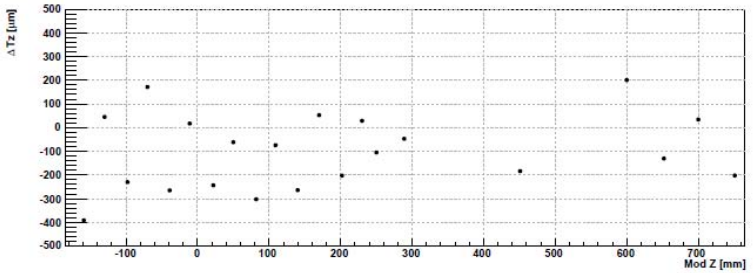


Right side

Sensor Translation







Alignment results

- Results still preliminary
- Anyway have a look at the results with the new alignment constants
- Only Velo reconstruction and with 0 outliers
- Comparing also to v3.1 alignment (other preliminary alignment by Wouter)

Sensor misalignment monitoring

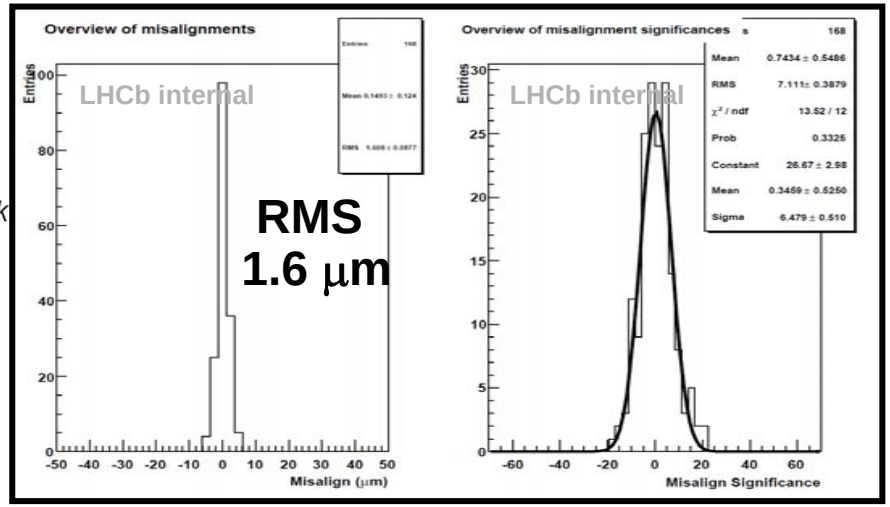
- R and ϕ residuals has a sinusoidal dependency on the misalignment

$$residual_R = -\Delta x \cos\phi_{track} + \Delta y \sin\phi_{track}$$

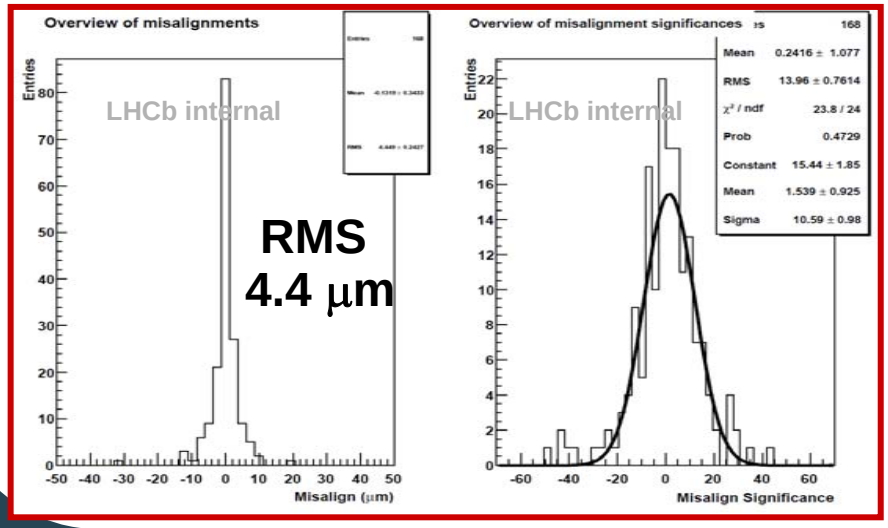
$$residual_\Phi = \Delta x \sin\phi_{track} + \Delta y \cos\phi_{track} + \Delta\gamma r_{track}$$

This method neglect the effect of Rx and Ry

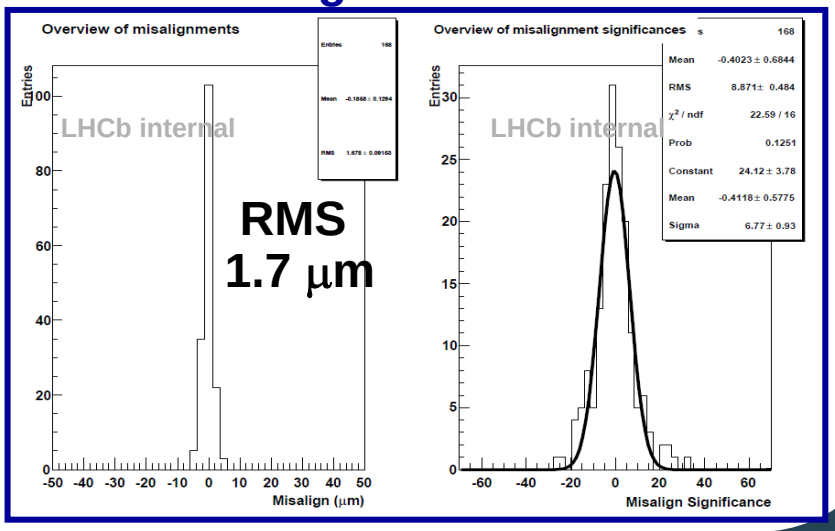
New Alignment



Current Alignment

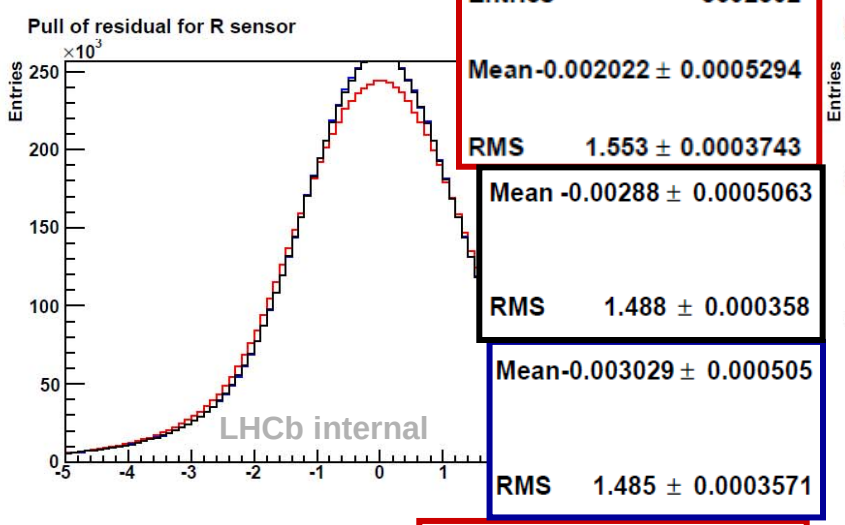


Alignment v3.1

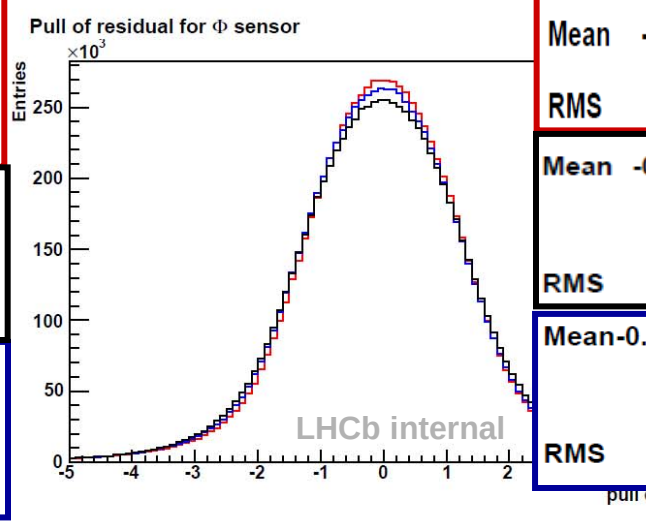


All Velo Tracks

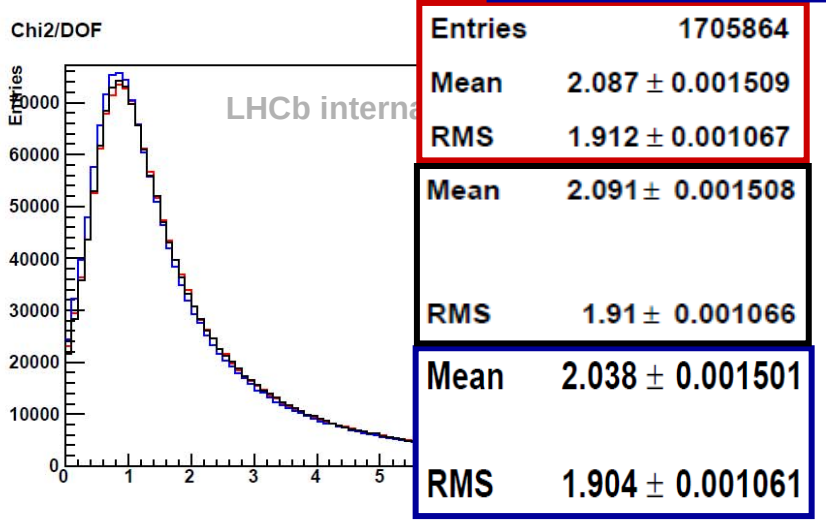
New Alignment
Current Alignment
Alignment v3.1



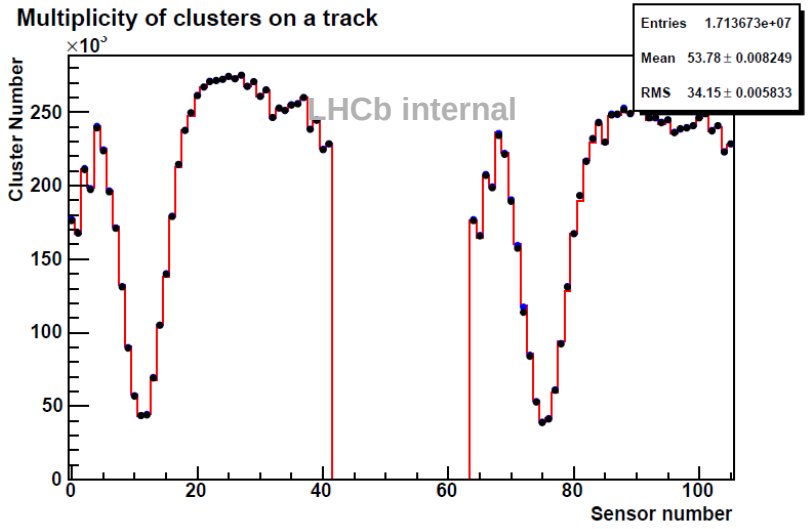
Entries	8602802
Mean	-0.002022 ± 0.0005294
RMS	1.553 ± 0.0003743
Mean	-0.00288 ± 0.0005063
RMS	1.488 ± 0.000358
Mean	-0.003029 ± 0.000505
RMS	1.485 ± 0.0003571



Entries	8217954
Mean	-0.001407 ± 0.0004546
RMS	1.303 ± 0.0003214
Mean	-0.0103 ± 0.0004733
RMS	1.359 ± 0.0003347
Mean	-0.01976 ± 0.0004623
RMS	1.329 ± 0.0003269

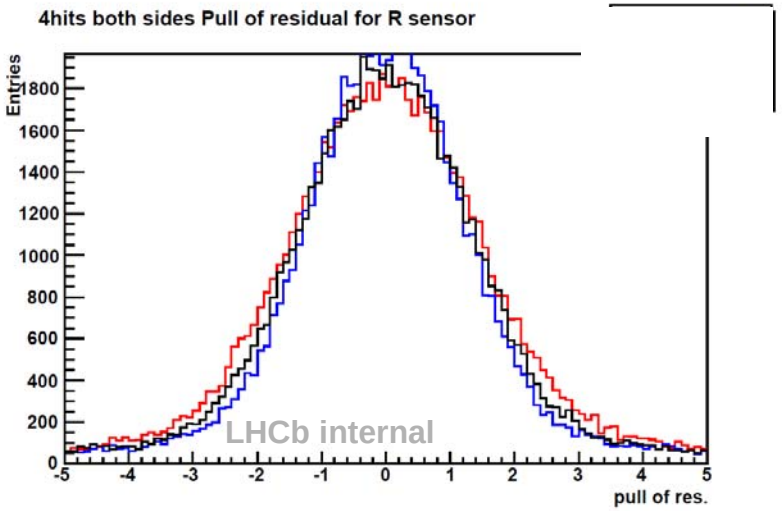


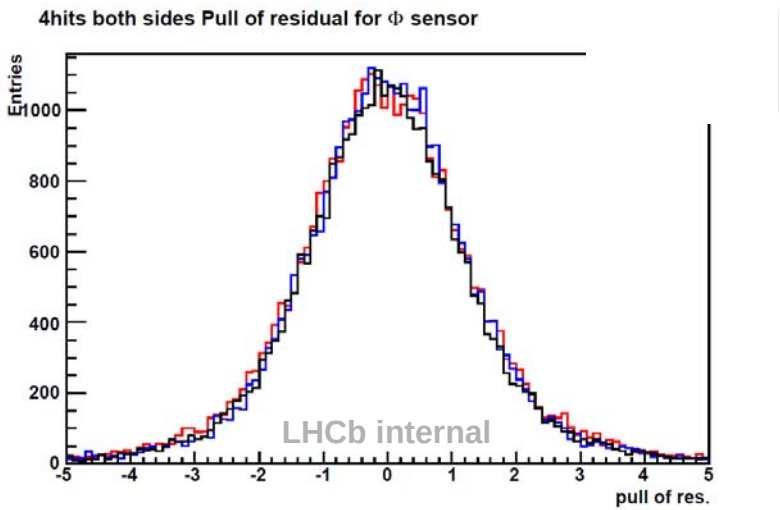
Entries	1705864
Mean	2.087 ± 0.001509
RMS	1.912 ± 0.001067
Mean	2.091 ± 0.001508
RMS	1.91 ± 0.001066
Mean	2.038 ± 0.001501
RMS	1.904 ± 0.001061

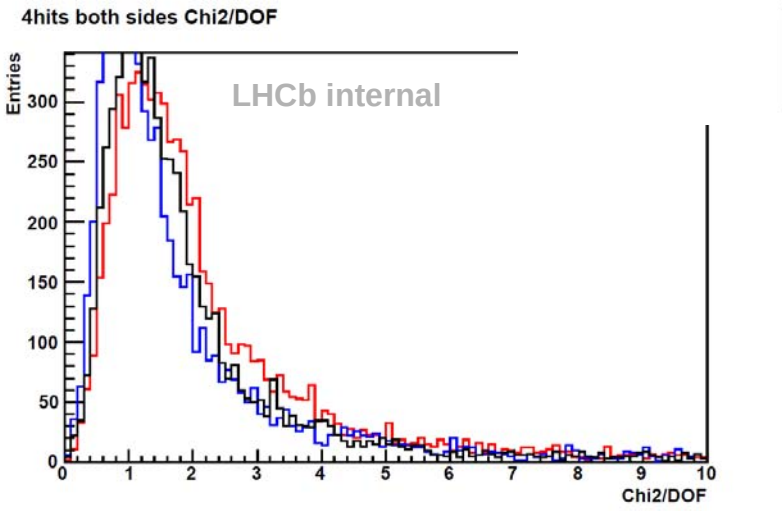


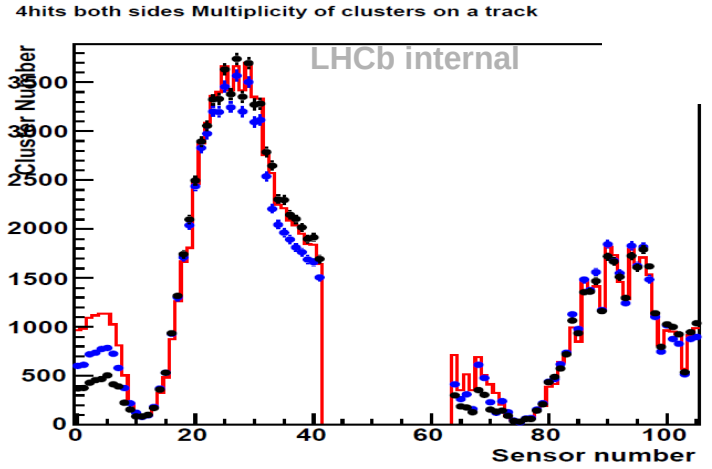
Overlap tracks with 4 hits in both side

New Alignment
Current Alignment
Alignment v3.1



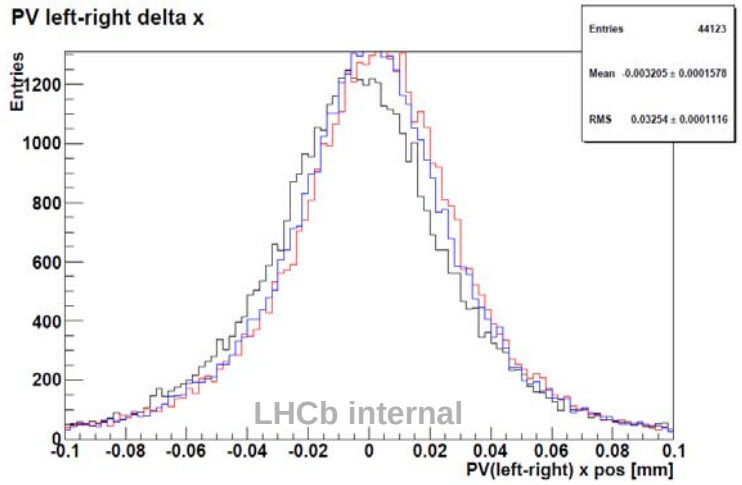


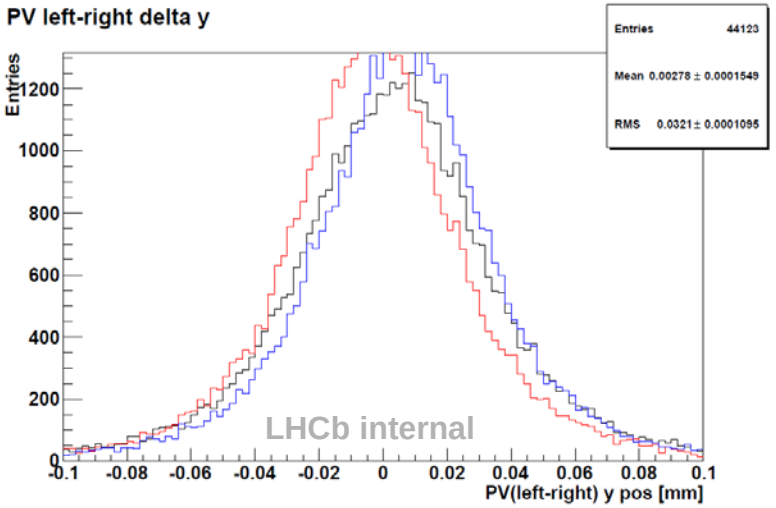


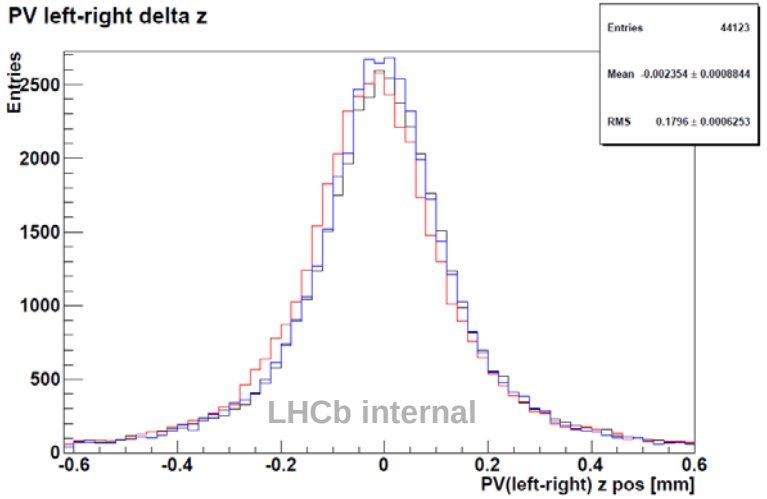


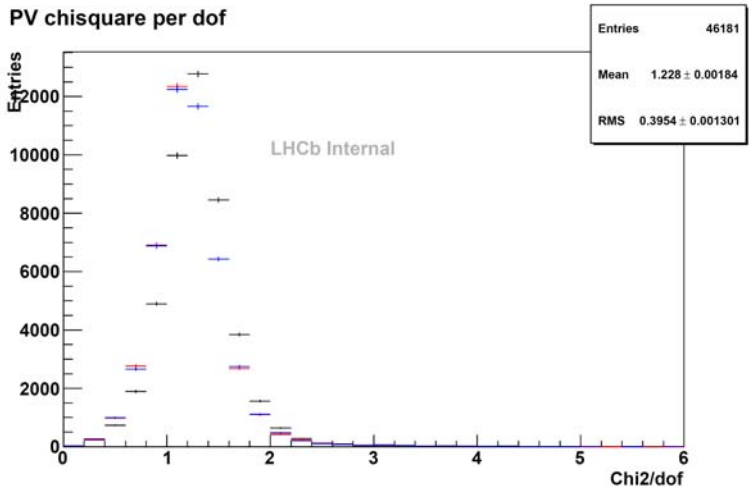
PV: Distance PV_{left}-PV_{right}

New Alignment
Current Alignment
Alignment v3.1









Conclusion

- New preliminary alignment is promising…
- But current alignment is better for overlap tracks and PV…
- Re-evaluate the two half alignment
  - Using the overlaps and PV to study better why 'inefficiency' for overlap tracks
- Next: study the sensor and module alignment stability on long period

Backup

Motion System Summary

- Three pieces of information available (through PVSS):
  - Steppermotor (number of pulses sent)
  - Resolver measurement
  - Potentiometer reading (detector safety system - 0.1mm accuracy)
- Motion accuracy for resolver position:
  - Position accuracy about ~10 μm
  - Position reproducible (moving in the same direction) ~3 μm
- In x:
  - Steppermotor sends 2000 pulses for 50mm (1:40 gearing)
  - 1mm in 9 seconds; i.e. 4½ minutes to drive 30mm
  - Open position is at |x|=29mm
  - Each half can drive up to 5mm beyond nominal x = 0
- In y:
  - Steppermotor sends 2000 pulses for 250mm (1:16 gearing)
  - 1mm in 3 seconds
  - Motion in y is only possible for |x|<16mm
  - Range is -4.7 < x < 4.7 mm